Improving Building Performance with Envelope Technologies

Thursday, August 23, 2018
4:00-5:30 pm
Improving Building Performance with Envelope Technologies

Moderator

- Melissa Voss Lapsa, Oak Ridge National Lab (ORNL)

Speakers

- Simon Pallin, ORNL
- Stacy Lambright, Hunter Douglas
- Laverne Dalgleish, Air Barrier Association of America
The commercial building envelope is the primary determinant of the amount of energy required to heat, cool, and ventilate a building.

Table 2. Primary Energy Consumption Attributable to Fenestration and Building Envelope Components in 2010 (Quads)\(^6\)

<table>
<thead>
<tr>
<th>Building Component</th>
<th>Residential</th>
<th></th>
<th>Commercial</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Heating</td>
<td>Cooling</td>
<td>Heating</td>
<td>Cooling</td>
</tr>
<tr>
<td>Roofs</td>
<td>1.00</td>
<td>0.49</td>
<td>0.88</td>
<td>0.05</td>
</tr>
<tr>
<td>Walls</td>
<td>1.54</td>
<td>0.34</td>
<td>1.48</td>
<td>-0.03</td>
</tr>
<tr>
<td>Foundation</td>
<td>1.17</td>
<td>-0.22</td>
<td>0.79</td>
<td>-0.21</td>
</tr>
<tr>
<td>Infiltration</td>
<td>2.26</td>
<td>0.59</td>
<td>1.29</td>
<td>-0.15</td>
</tr>
<tr>
<td>Windows (Conduction)</td>
<td>2.06</td>
<td>0.03</td>
<td>1.60</td>
<td>-0.30</td>
</tr>
<tr>
<td>Windows (Solar Heat Gain)</td>
<td>-0.66</td>
<td>1.14</td>
<td>-0.97</td>
<td>1.38</td>
</tr>
</tbody>
</table>

Barriers Identified for Envelope Technologies

- **Cost:** uncertainties, high first costs, ROI hurdles
- **Supply issues:** product fragility, availability, volume
- **Installation issues:** workforce training, complex systems, quality control
- **Decision culture:** resistance to new products, risk averse, code minimum culture
- **Information gap:** real world case studies, data on long-term performance, communicating effectively
Connecting Better Buildings partners with advanced building envelope technology solutions

- Technology verification studies
- Specification documents
- Case studies and fact sheets
- Calculators and analytic tools

Melissa Lapsa, M.B.A.
Building Envelope Technical Team Lead

Simon Pallin, Ph.D.
Building Envelope Technical Lead

Mahabir Bhandari, Ph.D.
Building Envelope Tech Team Support

Caroline Hazard, M.S.
Building Envelope Tech Team Support
A Unique and Diverse Team

- Demonstration of high performance envelope technologies and solutions
- Comprised of Better Buildings Partners and representatives from the design community, including A&E firms
Join the Team!

Members
(includes: Building Owners/Mgrs, Property Managers, A&E, Construction/ Installers)

- Adams 12
- Allegheny County Community College
- Arlington Initiative to Rethink Energy (AIRE)
- Brevard County School Board ok
- Clark Atlanta University ok
- Cook County Bureau of Asset Mgmt
- Emory University
- exp US Services, Inc.
- Green Dinosaur Inc.
- HOK
- Hersha Hospitality Mgmt
- Instituto Superior de Engenharia do Porto
- Legacy Health
- MA Dept of Energy Resources
- More
- Newmark Grubb Knight Frank
- Parkway Schools
- REI Co-op
- SABEY Data Centers
- Schmidt
- SIM²
- Smart Building Strategies LLC
- TN Office of Energy Programs
- Tishman Speyer
- Turner Construction Company
- US Army Corps of Engineers
- z2zero
Join the Team!

Friends
(Includes: Researchers, Academics, Trade Associations, Energy Service Providers, Manufacturers, Subject Matter Experts)

- Air Barrier Assoc of America
- American Institute of Architects
- AppleBlossom Energy, Inc.
- Argonne Nat’l Lab
- Association for Energy Affordability
- BA ConsulT
- BROAD U.S.A. Inc.
- Building Commissioning Assoc
- Building Envelope Materials (BEM)
- Covestro LLC
- Dow
- Dunsky Energy Consulting
- EIFS Industry Members Association
- Guardian Glass
- Humann Building Solutions
- ICF
- KUPU
- NanoPore
- National Fenestration Rating Council
- Northwest Energy Efficiency Alliance
- NRG Insulated Block
- Owens Corning
- QuadLock
- Renovate by Berkowitz
- Rmax Operating, LLC
- Sustainability Consultants LLC
- UNIFRAX
- USG Corporation
**What does the Envelope Team do?**

| Stakeholder Engagement | • **Recruit** Team members among BBA partners and representatives from the design community  
• **Collaborate** to advancing investment in envelope technologies with team discussions, webinars, and participation in market studies |
| Build Awareness | • **Prime the market** by strengthening building owners/manager's understanding of envelope technologies  
• Conduct envelope technology **demonstrations**  
• Provide **guidance and tech assistance** for envelope projects |
| Document and Validate Results | • Prepare **site M&V plans** for technology demonstrations  
• **Document results and produce case** studies and/or guidance for use in training, codes and/or standards |
| Technical Resources | • Online resources: **Windows, Walls, Roofs**  
• Specifications, guidance, case studies, fact sheets, etc. **addressing market barriers** and assist advancement of envelope technologies |
Current R&D Efforts

- Building Enclosure Commissioning
  - Benefits and Costs Study
  - Exploration of new enclosure performance metric
- Examination of Airtightness Requirements
  - Landscape Study
  - Sampling of air leakage rates
Simon Pallin
Oak Ridge National Lab (ORNL)
Building Envelope Market Potential

U.S. Primary Energy Consumption
98 Quadrillion Btu

- Transportation 28%
- Industrial 31%
- Buildings 41%
- Buildings-Residential 23%
- Buildings-Commercial 19%

In total = 5.81 Quads (5.81·10^15 Btu)

Commercial Buildings
- Lighting 20%
- Space Heating 16%
- Space Cooling 14%
- Ventilation 9%
- Refrigeration 7%
- Electronics 4%
- Water Heating 4%
- Computers 4%
- Cooking 4%
- Other 1%
Building Envelope Market Potential

Primary Energy Consumption for Commercial Buildings in 2010

- Lighting: 21%
- Space Heating: 16%
- Space Cooling: 14%
- Ventilation: 9%
- Refrigeration: 7%
- Electronics: 9%
- Water Heating: 4%
- Computers: 4%
- Other: 4%

In total = 5.81 (5.81·10^15 Btu)
Building Envelope Market Potential

Primary Energy Consumption Attributable to Fenestration and Building Envelope Components for Commercial Buildings in 2010 (Quads)

In total = 5.81 Quads
(5.81 \cdot 10^{15} \text{ Btu})
Building Envelope Market Potential

Primary Energy Consumption Attributable to Fenestration and Building Envelope Components for Commercial Buildings in 2010 (Quads)

- Roofs: 0.93 Quads
- Walls: 1.45 Quads
- Foundation: 0.58 Quads
- Infiltration: 1.14 Quads
- Windows (conduction): 1.3 Quads
- Windows (solar): 0.41 Quads

In total = 5.81 Quads

(5.81 \times 10^{15} \text{ Btu})

209 million tons of coal

~ 1000 million barrels of oil
What is the Building Envelope?
What is the Building Envelope?

- Water Resistive Barrier
- Air Barrier
- Thermal Resistance
- Vapor Barrier
- Light
- Noise
- (Structural Performance)
What is the Building Envelope?
Importance of Continuous Control Layers?

- Window to Roof/Wall
- Wall to Roof
- Wall to Slab
- Penetrations
- System Overlap
Importance of Continuous Control Layers?
Importance of Continuous Control Layers?
Constructed as Designed
Constructed as Designed
Factors that influence airtightness

- Construction design
- Floor area / Volume
- Penetration / Installations
- Material properties
- Workmanship
Field Study - Airtightness of 12 Identical Buildings

ACCH75
Primary Energy Consumption Attributable to Fenestration and Building Envelope Components for Commercial Buildings in 2010 (Quads)

- Roofs: 0.41
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- Windows (solar): 1.45

Outside Temperature

Temperature Set-points

Cooling Demand

Conductive Heat Losses

Air Infiltration

Heating Demand
Building Envelope Performance vs. Energy Demand

- Outside Temperature
- Cooling Demand
- Heating Demand
- Temperature Set-points
- Building Envelope Thermal Resistance
- Thermal Resistance
  - R-10
  - R-20
  - R-40

- No Energy
- Outside Temperature
  - 60
  - 65
  - 70
  - 75
  - 80
  - 85
  - 90
Building Envelope Performance vs. Energy Demand

Outside Temperature

Heating Demand

Cooling Demand

Building Envelope Thermal Resistance

Outside Temperature

NO ENERGY

60 65 70 75 80 85 90

R-40 R-20 R-10

NO ENERGY
Building Envelope Performance vs. Energy Demand

- Outside Temperature
- Cooling Demand
- Building Envelope Thermal Resistance
- Heating Demand
- Interior Heat Load

Outside Temperature

- 60
- 65
- 70
- 75
- 80
- 85
- 90

Energy Demand Levels:
- NO ENERGY
- R-10
- R-20
- R-40
Building Envelope Performance vs. Energy Demand

**Interior Heat Load**
- Solar loads walls and roofs
- Solar loads transmitted through windows
- Light fixtures
- Electronics
- Computers
- Air conditioning systems
- People
- Equipment
- ...

What if we can reduce the loads? Or even better, dispose of them on the demand?
Thank You

Simon Pallin, PhD
pallinsb@ornl.gov

Visit our website:
www.ornl.gov/buildings

Follow us on Twitter:
@ORNLbuildings
Maximizing Building Performance with Window Attachments

2018 Energy Exchange & Better Buildings Summit
August 23, 2018
Stacy Lambright, Hunter Douglas
Agenda

• Window attachments background

• Energy savings and other benefits of window attachments
  – Case studies

• AERC Overview
  – Commercial program development
  – Audience feedback
WINDOW ATTACHMENTS BACKGROUND
What are window attachments?

- Interior Shutters
- Cellular Shades
- Blinds
- Roller Shades
What are window attachments?

- Storm Windows/ Secondary Glazing Systems
- Awnings
- Exterior Roller Shutters
- Exterior Roller Shades
What are window attachments?

<table>
<thead>
<tr>
<th>Location</th>
<th>Interior or exterior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation</td>
<td>Manual, motorized, or automated</td>
</tr>
<tr>
<td>Design scenarios</td>
<td>New construction or retrofit</td>
</tr>
</tbody>
</table>
| Residential & Commercial | • Detached single-family and multi-family residential  
                          • Small commercial buildings, large apartment buildings, dormitories, nursing homes, assisted living facilities  
                          • Federally owned buildings (military housing, barracks, dormitories, and Veterans Administrations cares facilities)  
                          • Historic buildings  
                          • Large commercial and industrial buildings |
ENERGY SAVINGS
Windows make up 34% of a commercial building’s heating and cooling energy
How many of you are currently using window attachments to address energy savings and occupant comfort?
How can window attachments save energy?

- Attachments can help manage solar heat gain, air leakage, daylight, and glare
- Can reduce energy use from:
  - HVAC
  - Lighting
Beyond Energy

• Improved occupant experience and productivity
  – Thermal **comfort**
  – **Daylight** access
  – Glare reduction
  – Maintain **views**
Manually operated horizontal blinds combined with reflective ceiling and wall designs and photocontrols to adjust lighting

- 20 – 30% savings on electric lighting energy use
  - Higher savings if blinds were automated
Cambridge, MA Case Study
Genzyme (biotechnology company)

• Automated daylight-redirecting blinds help save over 45% of electric lighting energy use
New York City Case Study

1 floor in LEED Gold large office building

- Automated interior roller shades and LED lighting
- 79% energy savings
  - 14% attributable to optimized automated shades
• Highly insulating storm window retrofit
  – Additional 3 glazing layers
• 34 – 41% building heating load reduction during winter months
  – Estimated 9-year payback
• Occupants reported **improved thermal comfort** – reduced or eliminated use of personal portable space heaters
California Office Case Study

Sacramento Municipal Utility District Call Center and Office

- Access to quality views, reduced glare, improved ventilation, and daylight showed improvements in:
  - Worker productivity and focus
  - Physical and mental health
Value to Building Owners and Managers

• Energy savings
  – Decreased HVAC and lighting load

• Improved occupant satisfaction
  – Fewer complaints
  – Better occupancy and retention

• Automated attachments
  – Synergy across building systems (HVAC, lighting, attachments)
  – Self-managing
AERC is an independent, public interest organization whose mission is to provide consumers with credible, relevant, and comparable information about window attachments and their performance.

AERC members include:

- Public Interest Groups
- National Labs
- Commercial Labs
- Product Manufacturers
- Component Manufacturers
- Utilities
• Window attachments can save energy
  – Many consumers are unaware of their energy-saving capability
• Consumers have no way to compare the energy performance of attachments
• Energy Efficiency program managers also benefit from ratings and energy performance information
Residential Certification Program

- Launched in March 2018
- Products rated for:
  - U-factor
  - Solar Heat Gain Coefficient
  - Visual Transmittance
  - Air Leakage (as applicable)
  - Annual Energy Performance
    - Cold climate (Minneapolis)
    - Warm climate (Houston)
Residential Product Label and Website

Save energy and make your home more comfortable. Window attachments products with this label—such as blinds, shades, shutters and storm windows—can help you do both.

1. Look for the AERC Energy Improvement Label

Select the AERC Energy Improvement Label for the product you wish to purchase. This label indicates that the product meets energy efficiency standards.

2. Choose Your Climate

Determine your climate zone. The product you choose should be appropriate for your location. Refer to the chart to select the climate zone that best suits your needs.

3. Discover Your Energy Savings

Calculate the potential energy savings associated with the product. This information is based on the product's energy rating and your specific usage pattern.

Cool Climate Rating

Warm Climate Rating

Energy Rated. Added Comfort.

Did you know that window attachments—such as blinds, shades, and shutters—can help you save energy and make your home more comfortable? The energy rating label on the product indicates that it meets energy efficiency standards, helping you choose the best product for your needs.

Want to learn more? Visit www.AERCEnergyRating.org
Commercial Program Development

• AERC developing commercial certification program
• Identifying stakeholder needs (different from residential)
  – Product ratings
    • Energy performance (0-100)
    • Thermal comfort
    • Glare
    • Daylight
  – Energy modeling best practices for project-specific performance
  – Product selection guidance
  – Level of detail
• How do you currently make decisions about window attachments?
   – What information would make that process easier?
• What benefits have you had related to windows and attachments?
• Any other comments or suggestions for AERC?
THANK YOU!

Stacy Lambright
Energy Efficiency Product Manager
Hunter Douglas
stacy.lambright@hunterdouglas.com

info@aercnet.org
Laverne Dalgleish
Air Barrier Association of America
Where does air leak?
Where does air leak?

Anywhere it wants!
Types of air barriers
What does an air barrier do?
Makes a building operate properly!
Makes a building operate properly!

- Reduces air infiltration and exfiltration – saves energy/money
Makes a building operate properly!

- Reduces air infiltration and exfiltration – saves energy/money
- 10% to 40% savings of the building envelope energy requirements
Air Barrier Technologies

Makes a building operate properly!

**COMMON AIR LEAKS**

- Air Leaking into the house
- Air Leaking out of the house

- Duct Register
- Attic Hatch
- Recessed Light
- Plumbing Vent Stack
- Top Plate
- Sill Plate
- Crawl Space
- Home Envelope
- Dropped Soffit
- Dryer Vent
- Outdoor Faucet

*Source: U.S. EPA*
Makes a building operate properly!

- Can manage moisture in the envelope – liquid and vapor
Makes a building operate properly!

- Reduces sound transmission
Makes a building operate properly!

- Increases occupant comfort
Makes a building operate properly!
Makes a building operate properly!

- Makes fibrous insulation work as intended
Makes a building operate properly!

Graph 1: Wind Washing Effect on Thermal Insulation Performance

Source: Impact of Airflow on the Thermal Performance of Various Residential Wall Systems utilizing a calibrated hot box, Thermal Envelopes VI/ Heat Transfer in Walls – Principles
Makes a building operate properly!

- Improves performance of windows
Makes a building operate properly!
Makes a building operate properly!

- Buildings can withstand severe weather events
Makes a building operate properly!
Makes a building operate properly!

Air Barrier Technologies

Air Barrier Association of America
Makes a building operate properly!
Biggest Challenge to Air Barrier Performance
Biggest Challenge to Air Barrier Performance
Air Barriers Are The Future to Achieve Nearly Net Zero Buildings

Air Barriers Make your Building Work Today and Tomorrow
Thank you

Mr. Laverne Dalgleish
ldalgleish@airbarrier.org
Makes a building operate properly!

- Can manage moisture in the envelope – liquid and vapor
Makes a building operate properly!

MOLD

DAMAGE

WOOD ROT
Makes a building operate properly!

Moisture transfer into space due to air leakage

<table>
<thead>
<tr>
<th>Location</th>
<th>Base</th>
<th>0.25 L/m².s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miami</td>
<td>18 lb/ft²·year</td>
<td>2 lb/ft²·year</td>
</tr>
<tr>
<td>Chicago</td>
<td>12 lb/ft²·year</td>
<td>2 lb/ft²·year</td>
</tr>
<tr>
<td>Winnipeg</td>
<td>10 lb/ft²·year</td>
<td>2 lb/ft²·year</td>
</tr>
</tbody>
</table>
Makes a building operate properly!

- Reduces maintenance costs
Makes a building operate properly!
Makes a building operate properly!

- Reduces sound transmission
Makes a building operate properly!

- Increases occupant comfort
Makes a building operate properly!
Makes a building operate properly!

- Makes fibrous insulation work as intended
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Idalgleish@airbarrier.org
Makes a building operate properly!

- Reduces sound transmission
Makes a building operate properly!

Transmission path in real building

Objective is sound insulation for occupants (system performance)
- described by Apparent Sound Transmission Class (ASTC)
Makes a building operate properly!

- Makes the HVAC system work as intended
Makes a building operate properly!

- Makes the HVAC system work as intended
- Reducing energy use by the mechanical equipment
Makes a building operate properly!
Makes a building operate properly!

- Increases occupant comfort
Makes a building operate properly!
Makes a building operate properly!

- Makes fibrous insulation work as intended
Makes a building operate properly!

Graph 1: Wind Washing Effect on Thermal Insulation Performance

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Idalgleish@airbarrier.org
Collaboration: the Envelope Tech Team

Engage and support Members in efforts to accelerate adoption of building envelope technologies

- Build awareness with guidance and information on envelope technology solutions
- Conduct envelope technology verification studies
- Offer technical assistance for envelope projects
Check out the Envelope Tech Team Web Resources

- **Topic Areas**
  - Windows
  - Walls
  - Roofs

- **Resources**
  - Case Studies
  - Calculators
  - Design Guides
  - Fact Sheets
  - Toolkits
  - …and more…

https://betterbuildingsinitiative.energy.gov/alliance/technology-solution/building-envelope
Join the Envelope Tech Research Team!

Email: lapsamv@ornl.gov

Engage in R&D:
• Addressing airtightness requirements
• Investigating Building Enclosure Performance Metric

To join, email Melissa Lapsa: lapsamv@ornl.gov
Thank you!

Moderator

- Melissa Voss Lapsa, ORNL, lapsamv@ornl.gov